Forest Canon Reservoir

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Julian Hayden

1907

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Forest Canon Reservoir

FOREST [illegible] RESERVOIR.

A Thesis

Presented by

Albert Hayden, Jr.

Julian Hayden.

To the

President and Faculty

of

Armour Institute of Technology

for the degree of

Bachelor of Science in Civil Engineering.

Having completed the prescribed course of study in

Civil Engineering.

May [illegible], 190[illegible].

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L. C. Monin,
Dean of Cultural Studies.

Alfred E. Phillips
Prof. Civil Engineering

Howard M. Raymond.
Dean of Engineering Studies

Typical Mountain Lake.

Park in Hayden Branch.

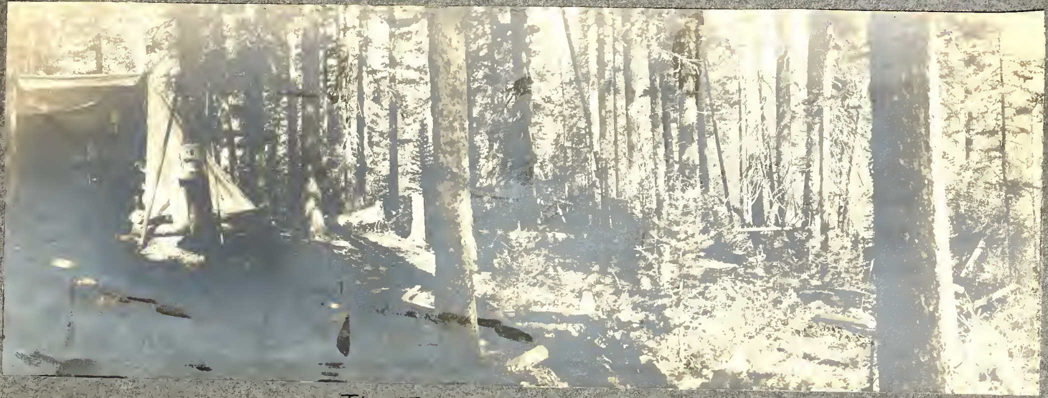
THE FOREST CANON RESERVOIR.

The proposed Forest Canon Reservoir is situated in the main mountain branch of the Big Thompson River. A reservoir in this section of the country is desirable for several purposes: power, light, and irrigation. The power developed from the reservoir could be utilized to operate a trolley line between Estes Park, which is rapidly becoming one of the most popular of our Western Summer Resorts, and its nearest railroad point, Loveland, which is about 45 miles distant. Electric light for the hotels and cottages could also be furnished from the same source. Another advantage of the scheme is that the water could also be used for irrigation during the dry season.

A market for the power is not dependent upon Estes Park alone, for there are in the neighborhood of Loveland, Longmont and Boulder many factories that depend upon power companies for their supply. These power plants develop steam power by means of a cheap quality of coal mined on their own property. It is thought that water power from the mountains can be made to compete successfully with even the cheapest of steam power.

THE DRAINAGE AREA.

The drainage area of the reservoir is large enough to supply all the water necessary. It is made up of three great canons, Forest Canon, Hayden Branch and Arrowhead Branch. All of these canons run into the mountains high above timber line and contain lakes, streams and large snow banks.



The Thick Timber in Forest Cañon.

THE SURVEY.

The first [illegible] party [illegible] a trail [illegible] the country. This [illegible] on July [illegible] camp [illegible] up on three horses. N[illegible] the [illegible] the following day a permanent camp was built.

On the next day the Survey was commenced. A line of levels was run from the [illegible] from [illegible] it was seen that a 30-foot dam would [illegible] water only about one eighth of a mile. It was, therefore, decided to run the Survey for a dam 40 feet in height.

The Survey was made by means of course and distance. The 40-foot or high-water line was run and stakes were set at grade points. This line was then transited. The stream was meandered and topography sufficient for a [illegible] five-foot [illegible] taken. Wherever possible, stations for the topography were taken on the forty-foot stakes. The Survey was rendered difficult on account of the thickness of the timber and the size of the party, which consisted of but three men. The thickness of the timber can be best shown by an example. In the [illegible] work the longest sight obtained was only 2[illegible]1.8 ft. and this at the expense of much clearing.

The location of the dam was determined by the natural formation of the Thompson Canon. The river below the dam site flows directly into a box canon and there is very swift and [illegible] rapids and falls. Above the dam site the river runs nearly due east and the

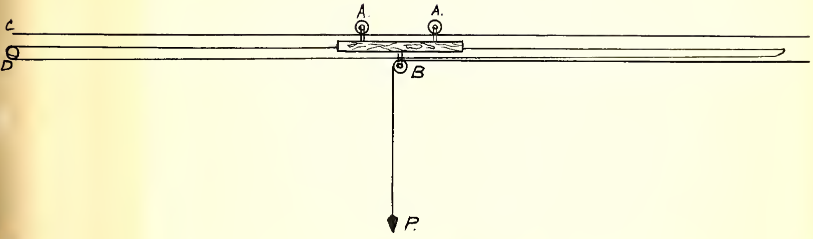
The Camp.

Clearing for Long Shot.

canon opens [illegible] at the end of about four miles it enters what is known as the second box canon and again becomes a [illegible]. It will be seen from this that the only place for the location of the dam is [illegible] of the lower box canon.

At the dam site the stream flows practically west and east. The south bank is a precipice 40 feet high and [illegible] a very steep slope. The north bank is also a very steep slope which develops into a sheer cliff 10 ft. below the lower cross section of the dam site. In both of the rock cliffs are fissures which can be enlarged to provide ample anchorage for the dam.

The diagram given below shows the method of using the [illegible] in cross sectioning the stream.



The method of cross sectioning the stream was as follows: A heavy chalk line was stretched across the canon and on this a trolley was supported by means of the two pulleys, A. A. The trolley was

The Traveller in Action.

moved back and forth by a cord graduated in tenths of a foot. This cord passed around a pulley on the opposite bank. By means of this arrangement the traveller could be run out any desired distance. On the lower side of the traveller was fastened a pulley B. over which a cord graduated to tenths [illegible] was passed. The trolley was run out a distance of five feet and the plumb bob dropped to the bottom and the elevation of the bottom obtained by means of the transit which was set over a point of known elevation. Elevations were obtained in this way at intervals of five feet all the way across the stream. Cross sections were made in this way at intervals of ten feet and parallel to each other as far as it was thought the dam would extend.

GAUGING THE STREAM.

The stream was gauged by the method of surface floats. After considerable search a stretch of stream was found which was about 50 feet in length and where the current was not broken by ripples or eddies. A cross section of this part of the stream was made in the following way: A steel tape was stretched across the stream and readings were obtained at intervals of two feet by means of a rod. From the data thus obtained an accurate cross sectional area was obtained.

In order to get a fair mean value for the velocity 14 floats were used, each float being started in a different part of the stream. Time was measured between two gun shots, one fired as the float was

In Forest Cañon.

Forest River.

started and the other as it crossed the lower limit of the measured reach. The [illegible] were [illegible] by the rapids and falls in the stream below.

GAUGING THE STREAM.

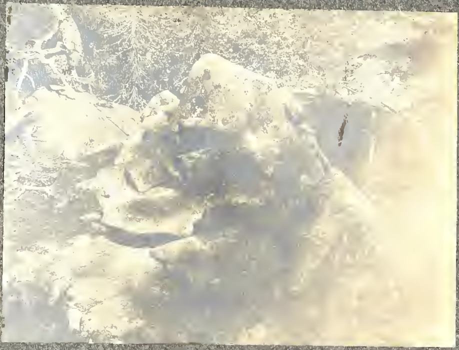
FLOAT	TIME
1	[illegible] seconds
2	[illegible] "
3	37 "
4	20 "
5	15 "
6	[illegible] "
7	10 "
8	11 "
9	11 "
10	[illegible] "
11	11 "
12	15 "
13	15 "
14	13 "
Mean	16.57 seconds

Length of reach 50 ft.

50/16.57=3.01 ft./sec. Surface velocity.

Q=AV where A is the area of cross section and V the velocity in feet per second.

Q=36.7 X 3.01=110.5 cubic ft./sec.



The Cairn.

South Anchorage.

From Merriman's [illegible], [illegible] velocity to the surface [illegible] is ...

110.3 X .05= [illegible].

As the Survey [illegible] connected with [illegible] there [illegible] here to tie it to. [illegible] a large cairn, or monument [illegible] formed [illegible].

From the notes [illegible] the [illegible] of the [illegible].

[illegible]

Area of Reservoir, [illegible] acres at high water line.

Volume, 13,37[illegible],000 cubic feet.

The areas were obtained from the contour map [illegible] Crosby polar planimeter.

The volume was determined by the formula:

$$V=\frac{h}{6}\left[a+4a_2+2a_3+4a_4+\cdots a_n\right].$$

Where h is double the contour interval and A, A₂ [illegible] the areas of the contour planes.

In addition to the map of the Reservoir a contour map and a profile of the cross section of the dam site were drawn.

THE DAM.

After consideration, it was decided to make the dam of the timber crib type for the following reasons: Forest [illegible] inaccessible place. All materials which would go into [illegible] reinforced concrete would have to be brought by rail to [illegible] and from there to Lyons or Loveland. From Lyons or Loveland [illegible]

[illegible]

[illegible] draining [illegible] of the [illegible], [illegible] used in the construction of a [illegible] dam [illegible]. [illegible] gravel [illegible], [illegible]; [illegible], [illegible]; [illegible] practice in the [illegible] of [illegible] [illegible].

In order to [illegible] logs in the dam are to be [illegible]. The logs used in the construction should be at least one foot in diameter and spiked to the posts with [illegible]. All logs [illegible] as possible [illegible].

Weight of [illegible] at the lowest point [illegible] the [illegible].

[illegible] of [illegible].

[illegible] solid [illegible] distance of three feet.

The dam is not [illegible] in case of emergency such as a [illegible] flood. The [illegible] taken care of [illegible] channel in the [illegible].

BIBLIOGRAPHY.

Wegmann, Design and Construction of Dams.

Construction of Timber Dam at C[illegible] Falls, Eng. News, 1900, Vol. 43, page [illegible].

Timber Dam at the Outlet of Chamcook Lake, [illegible], Eng. News, 1904, Vol. [illegible], page 121.

Chamcook Timber Dam, Eng. Record, 1904, Vol. 50, page 70.

Hardesty, The Bear River Irrigation System, Utah. Eng. News, [illegible], Vol. 75, page 93.

Bishop, The Lachine Rapids Power Plant, Montreal P. Q. Eng. News, [illegible], Vol. 37, page 91.

Brown, Partial Failure of Timber Dam, Near Butte, Mont. Eng. Record, [illegible], Vol. [illegible], page [illegible].

Turneaure and Russell, Public Water Supplies, Chapter 14, page 390.

Trautwine, Engineers' Pocket Book. Timber Dams, [illegible].

Wilson, Irrigation Engineering, Article 1[illegible], page [illegible].

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MAP OF THE

FOREST CAÑON RESERVOIR

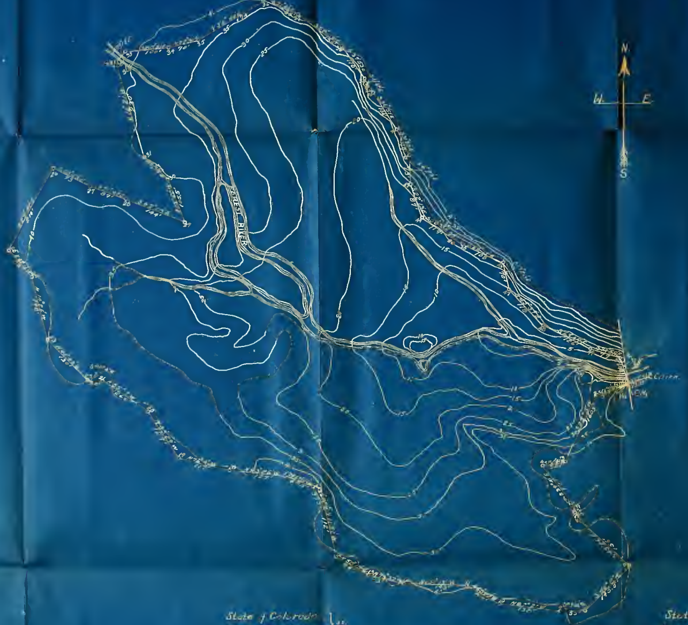
LARIMER COUNTY COLORADO

Irrigation Division No 1. *Water District No 4*

Degrees True Magnetic Variation 14°30'E

Scale of Map 1 inch = 100 feet

Contour Interval 5 feet



Statement

Know all men by these presents: That the undersigned, Albert Hayden Jr. Julian Hayden and Robert Sherman Larimer claimants, whose post office address is 3133 Michigan Ave. Chicago Ill., have caused to be located The Forest Cañon Reservoir as hereinafter mentioned, have made these several statements relative thereto, and filed in compliance with the laws of the State of Colorado. The accompanying map which shows the location of the said reservoir, forms a part of this filing and is hereby made a part thereof.

Height of dam 46 ft.

The following table gives the areas and capacities for each foot in depth from the bottom of the outlet tube up to and including the high water line.

Depth in ft. bottom to outlet	Area Sq. ft.	Capacity Cu. ft.
0-1	[illegible]	2198.5
0-2	601.3	4397.7
0-3	901.9	6595.4
0-4	1202.6	8793.9
0-5	1503.3	10992.4
0-6	[illegible]	13190.9
0-7	3773.0	15389.3
0-8	4907.9	[illegible]
0-9	6072.8	[illegible]
0-10	7199.7	[illegible]
0-11	8164.1	35245.6
0-12	9150.6	[illegible]
0-13	10137.0	[illegible]
0-14	11123.3	[illegible]
0-15	12110.0	[illegible]
0-16	[illegible]	[illegible]
0-17	[illegible]	115160.3
0-18	19392.2	128471.0
0-19	21819.3	[illegible]
0-20	24247.0	166092.6
0-21	27917.6	[illegible]
0-22	31598.2	[illegible]
0-23	[illegible]	280138.6
0-24	[illegible]	[illegible]
0-25	42600.0	[illegible]
0-26	[illegible]	[illegible]
0-27	47738.0	[illegible]
0-28	[illegible]	[illegible]
0-29	[illegible]	[illegible]
0-30	[illegible]	[illegible]
0-31	59280.0	648192.8
0-32	[illegible]	[illegible]
0-33	66950.0	801653.3
0-34	[illegible]	878233.5
0-35	[illegible]	[illegible]
0-36	80807.3	[illegible]
0-37	86994.6	1107774.1
0-38	[illegible]	[illegible]
0-39	99369.2	[illegible]
0-40	[illegible]	[illegible]

Total capacity of said reservoir is 13,339,142 cu. ft. of water, for which claim is hereby made for irrigation and power purposes.

The source of supply of said reservoir is from the Forest Cañon branch of the Big Thompson River.

The estimated cost $ [illegible]

State of Colorado
County of Larimer } s.s.

Albert Hayden Jr. Julian Hayden and Robert Sherman Larimer claimants, being duly sworn on oath depose and say that having read and examined the map and statements hereon, that the same are true to the best of our knowledge and belief.

Subscribed and sworn to before me this day of A.D. 19

My commission expires

Notary Public.

State of Colorado
County of Larimer } ss.

Albert Hayden Jr. Julian Hayden and Robert Sherman Larimer being duly sworn on oath depose and say that they are the engineers of the Forest Cañon Reservoir, that the survey of same and the map thereof was made by them and that such survey is accurately represented upon this map; that they have read the statements thereon and that the same are true to the best of their own knowledge.

Subscribed and sworn to before me this day of A.D. 19

My commission expires

Notary Public.

State Engineer's Office
Denver Colo.

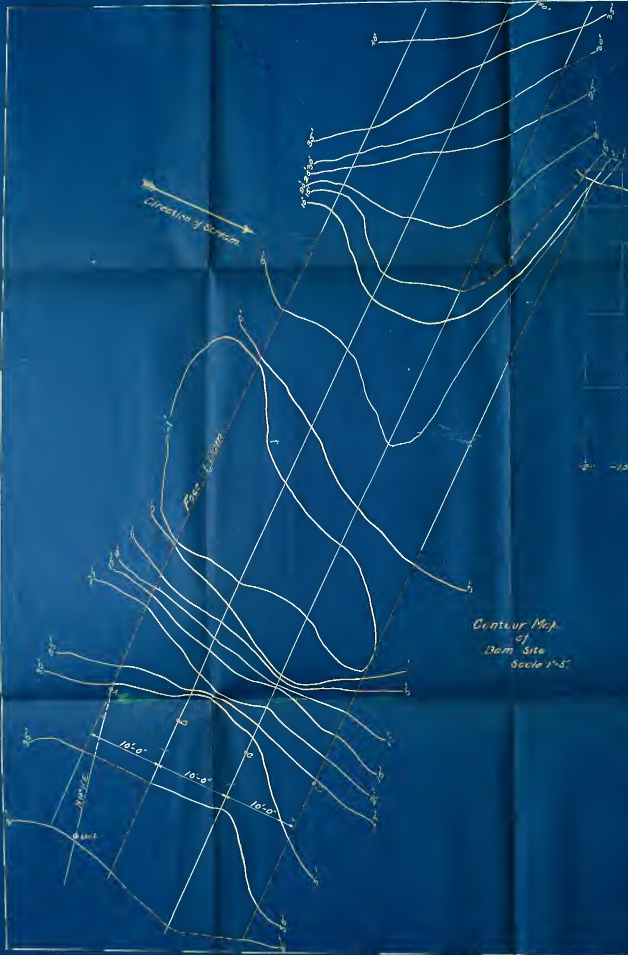
State of Colorado
City and County of Denver } ss.

I hereby certify that this map and statement has been examined and approved by me as agreeing with the statutes of the State of Colorado and the regulations of this office and was accepted for filing on the day of A.D. 19

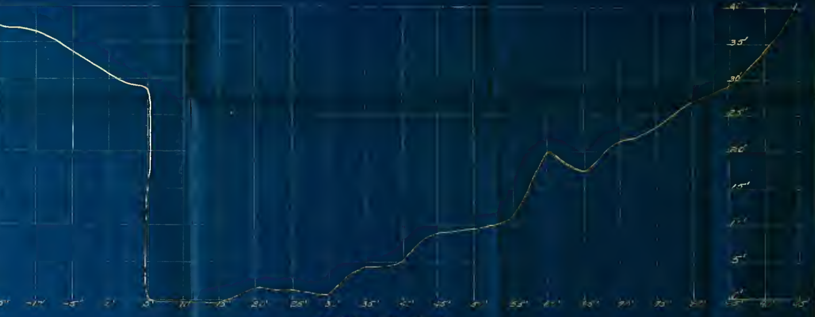
State Engineer.

By

Deputy.

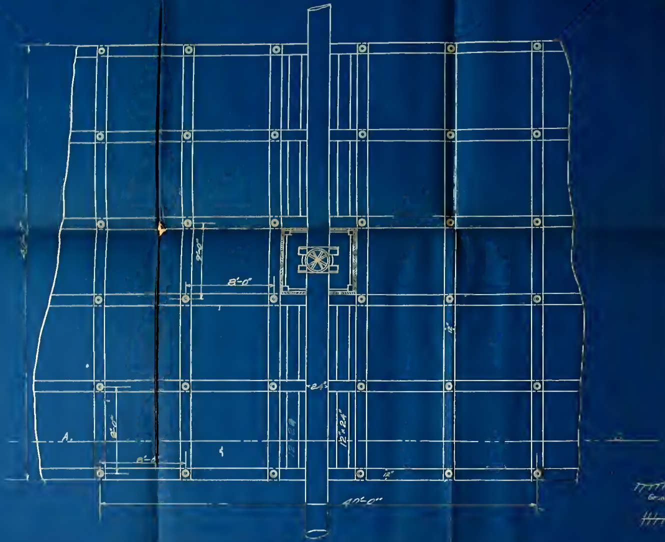

Direction of Stream
Face of Dam
10'-0"
10'-0"
10'-0"
40'
35'
30'
25'
20'
15'
10'
5'

Contour Map
of
Dam Site
Scale 1"=5'.

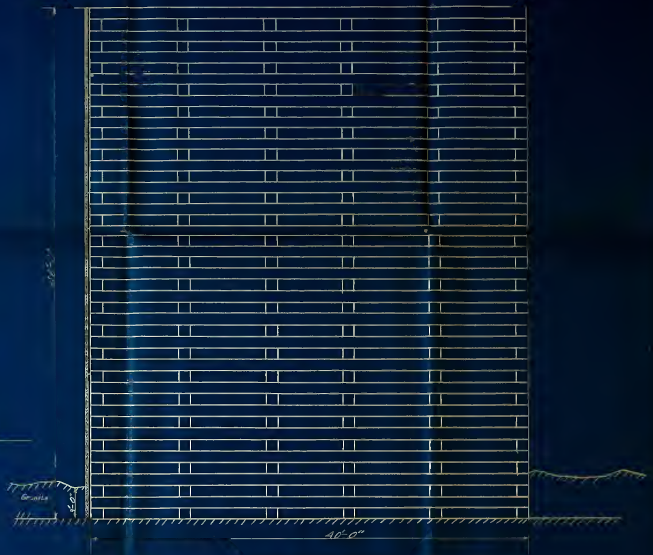


Profile at Section C.
Scale 1"=6'.

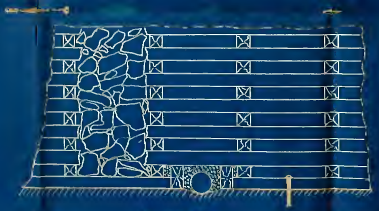
Contour and Profile
of
Forest Canon Reservoir Dam.
Chicago Ill.
March 24, 1907.


8'-0"
9'-0"
8'-0"
8'-0"
24"
12"x24"
12"
12"
40'-0"
A

Plan
Showing Valve Chamber


Granite
3'-0"
40'-0"

Cross-section of Crib.



Section at AB.

Anchor Bolts 2'lg-1"Sq.
Bolts spaced 4'c.c.

Bolts @ intersections 2'lg×1"sq.
All Planking 2" thick.

Timber Crib Rock Fill Dam.
for
The Forest Cañon Reservoir.

Chicago Ill.
March 28, 1907.

Scale 1"=4'

Julian Hawden